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THE DURIP AWARD WAS USED TO PURCHASE TWO PIECES OF INSTRUMENTATION IN SUPPORT OF ONE OVERREACHING GOAL OF THE AFOSR FUNDED PROGRAM: CORRELATION OF GROWTH CONDITIONS OF SILICON CARBIDE BOULES AND THEIR STRUCTURAL CHARACTERISITICS.

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Grant title:	"DURIP: Acquisition of Single and Double Crystal X-Ray Topography System".
Grant Number:	F49620-00-1-0249
Funding Agency:	AFOSR
Award period:	03/28/2000 –06/30/2001

The DURIP award was used to purchase two pieces of instrumentation in support of one overreaching goal of the AFOSR funded program: correlation of growth conditions of silicon carbide boules and their structural characteristics.

The x-ray topography unit was ordered in September of 2000 and manufactured and delivered to Carnegie Mellon University in January of 2001. The installation was completed in March 2001 and was followed by extensive alignment and testing. The photograph of the system is shown in Fig. 1

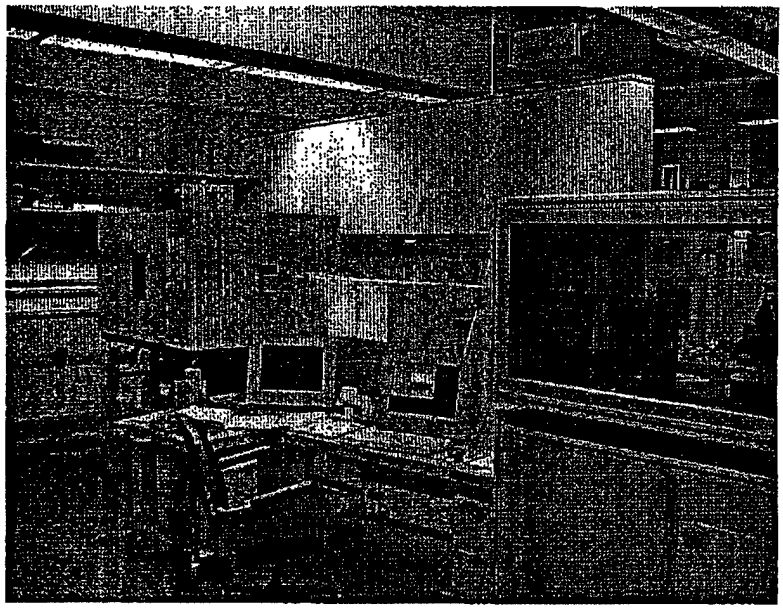

Fig. 1 X-ray topography system installed in Wean Hall 8302. The cabinet on the left side houses Lang camera, cabinet on left encloses the double crystal topography unit.

The system is producing valuable data for several federally funded projects including:

1. "Growth of semi-insulating 6H-SiC crystals for GaN-based microwave devices" funded by Air Force Research Laboratory, POC: L. S. Rea, phone: (937) 255-4474 ext. 3213, principal investigator: M. Skowronski
2. "Structural defects in semi-insulating SiC wafers" funded by Air Force Office of Scientific Research, POC: Maj. D. Johnstone, phone: (703) 696-7545, principal investigator: M. Skowronski
3. "High Volume, High Quality Silicon Carbide Substrate Merchant Manufacturing" subcontract to Sterling Semiconductor, Inc., "Three Inch SiC substrate manufacturing", subcontract to Airtron Litton Corporation, Air Force Title III program, POC: J. Blevins, Air Force Research Laboratory, (937) 255-3701 ext. 226, principal investigator: M. Skowronski
4. "Identification of Screw Dislocation Sources in SiC PVT Growth" funded by Office of Naval Research, POC: C. E. Wood, phone: (703) 696-4218, PI: M. Skowronski
5. "Mechanisms of Extended Defect Nucleation during PVT Growth of Silicon Carbide" funded by National Science Foundation, POC: L. Hess, (703) 292-4937, PI: M. Skowronski

The system is intensively used for imaging extended defects in silicon carbide crystals grown by Physical Vapor Transport method and in silicon carbide high voltage diodes. Among the major findings accomplished with the help of x-ray topography are:

1. Evidence of plastic deformation occurring during crystal growth of SiC boules. This effect causes the dislocation multiplication and resulting densities in the 10^5 cm^{-2} range.
2. Evidence of dislocation serving as nucleation sites for stacking faults under forward bias. This leads to the degradation of SiC bipolar devices through increase of forward voltage drop. Both the stacking faults and pre-existing dislocations have been imaged using x-ray topography.
3. Evidence of stacking faults formation during initial stages of SiC growth leading to nucleation of screw dislocations. These defects are known to reduce the intrinsic

breakdown voltage of silicon carbide through formation of isolated microplasmas. Current density of screw dislocations in state-of-the-art wafers is above 10^3 cm^{-3}. Carnegie Mellon University demonstrated growth approaches resulting in densities as low as 10^1 cm^{-2}.

The example of a x-ray topograph obtained using the system acquired with AFOSR funds is shown in Fig. 2. The inclined lines forming 60o angle correspond to two sets of basal plane dislocations with Burgers vectors of a/3<11-20> and a/3<2-110>.

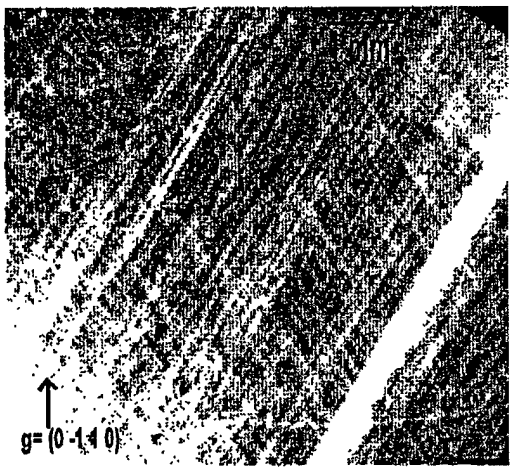

Fig. 2 X-ray topograph of a high quality 4H-SiC wafer with straight basal plane dislocation segments.

The RF power supply was purchased from Mesta Electronics and delivered in March 2001. It has been used since in the silicon carbide growth effort producing crystals used programs listed above. It is also expected that the inverter will contribute to the program recently funded by DARPA Wide Band Gap Initiative as part of the project on "Halide CVD SiC Growth".